ANSWERS!
NAME_____ Heat & Molecules PACKET See also pgs 357-370

STARTER:

WHAT IS HEAT?
Total amount of energy transferred by molecular movement.

WHAT IS TEMPERATURE?
Average kinetic energy of molecules

HOW ARE THEY MEASURED?
Heat: Joules or Calories of energy needed to make something hotter
Temperature: degrees, measures average movement of molecules.

When heat is added to a substance (liquid), it could do four things:
It could change temperature
ΔQ = Mass * SpecificHeat* Change in Temp

It could change phase
ΔQ = Mass *HeatFusion or Mass*HeatVaporization

It could expand (doing work) or compress (having work done on it)
ΔQ = ΔWork = Force*ΔDis or ΔWork = Pressure * ΔVolume

It could undergo a chemical reaction, exo or endo thermic.

Heat is related to the Conservation of Energy

All of our ideas on energy still hold true, energy can be transformed from one type to another or transferred from one object to another.
ΔKE + ΔGPE +Δ EPE + ΔWork + ΔQ (Heat) + ΔElec + ΔQ stays constant

HEAT

READ:

Heat and temperature are related, but they are different from each other.

HEAT is a form of energy that is transferred, and depends on the total mass of the object, and how much energy each particle can give off (the bonds, etc). Heat makes molecules move faster and spread out, or change phase, or chemically react.

TEMPERATURE is a measure of the AVERAGE heat energy of each object. It is really a measure of the average of the internal kinetic energy.

Each of these is related to the speed of the molecules. You can think of HEAT as being the total speed of the molecules added together and the temperature as being the average speed of all the molecules. For any object, a gain in heat energy is shown by a rise in temperature. A loss of heat energy is usually shown by a drop in temperature. Therefore, heat is energy, while temperature is an average measurement of that energy.

A thermometer is used to measure temperature, which is the average energy of each of the molecules in a substance. It does NOT depend on the amount or mass of the substance. Temperature is measured in degrees. On the Celsius scale, 0 degrees is the measurement at which water at sea level freezes, and 100 degrees is the measurement at which water at sea level boils. -273 degrees Celsius is also known as absolute zero, which is the temperature at which the average speed of the molecules is zero. (It is almost as if temperature is heat per mass)

Heat <u>can</u> also be measured. Since it is energy, heat is measured by how much energy one object can give another. A campfire could have a lot of heat, but the same temperature as a match. Heat can be measured in Calories, which is the amount of energy needed to heat 1 liter of water up 1 degree Celsius. (It is almost as if heat is temperature times mass)

Heat can be transferred by electromagnetic radiation coming from atoms and traveling as INFRARED RADIATION, or by other radiation (such as LIGHT) hitting atoms and changing to HEAT.

Heat can also be transferred by molecules bumping into each other as they are vibrating, usually in solids. This is CONDUCTION, and depends a lot on the type, and density of molecules.

Heat can also be transferred as changes in density causes groups of molecules to actually MOVE, to rise, and sink, as density and temperature change. This is CONVECTION, usually in liquids and gases.

Therefore, the total mass of an object affects its heat, and the composition of an object (what kinds of atoms/molecules it has) affects its heat. Objects with the same temperature can have more heat based on mass and/or their composition (specific heat). Water takes 4187 J/kg to heat 1 degree Celsius.

Which gives off more heat, a match, or a blazing campfire? Which has more temperature? Explain:
A (burning) match of wood and a campfire of wood have the same temperature, but the campfire has more heat because it has more mass.

Is it possible for an object that is at a lower temperature than a second object to give off more heat energy than the second object? Explain:
Sure, I could be hotter than you, even if you have a fever IF I have much more mass!

How do changes in temperature affect an object like a thermostat? How do you think a thermostat controls heat?
A thermostat has a bi metal strip. Each side expands and contracts differently and as it contracts (when cold) it makes contact with a switch that causes your heat to go on. When it expands, it loses contact and your heat goes off.

What happens when you bring together an object with a lot of heat energy together with an object with a little heat energy?
Heat flows from the hot to the cool object (2nd Law of Thermodynamics)

Do your senses detect changes in temperature or changes in heat?
HEat

For each item place, whether it transfers heat by Radiation, Conduction, or Convection: __***R***__ Light Bulb in a vacuum _***R***_ _***Cv***__ Light Bulb in Air __***Cd***__ Metal spoon ___***Cv***__ boiling water _***Cv,R***___ campfire _***Cd***___skin _***Cv***__ Jet stream __***Cd***____ curling iron

If two samples have the same temperature AND the same mass, ***how could they have different amounts of heat?***
If they are different materials.

If two samples have the same temperature AND are the same type of object, ***how could they have different amounts of heat?***
If they are different mass

How does this prove to you that heat and temperature are different for every type of object?

It does, because heat depends on both material and on mass.

Experiments

All you will need is a piece of metal, such as a lid from a jar. (Like a baby food jar) The jar lid should be cool, about room temperature. First, place the top side of the lid against one side of your nose. ***Record the sensation*** you feel. Which feels warmer, the jar lid, or your nose?

Next, hold the jar lid in you hand closely for about 30 seconds and hold it against your nose. ***Record the sensation***.

Wait two minutes for the jar lid to return to room temperature. Next, vigorously rub the top part of the lid on your clothing for about thirty seconds and hold it against your nose. ***Describe the sensations you feel***.

How soon does it take the jar lid to return to the original temperature? ***Record all your observations***,

Use other materials besides a metal lid if you can. ***Describe what happens*** at each step.

Then:

Explain, in terms of molecules of the lid, your nose, the air, the clothes, your palm moving, bumping, speeding up, or slowing down, ***what happened*** at each step of the experiment.

Pg 358 TRIES THIS Get three cups or bowls of water, one hot, one cold, one warm. Place one hand in the hot water at the same time you put the other hand in the cold water. After a minute, place both hands in the third container (the warm water with temperature right between the other two). Does the water in the third container feel the same to both hands? How does it feel? Try to explain your observations:

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pg. 368 Drop or shake something. Does it heat up? Why?

QUESTIONS

BE READY to explain the relationships between the following ideas:

SPEED TEMPERATURE MOLECULES

HEAT INCREASING HEAT DENSITY

EMPTY SPACES DECREASING HEAT FASTER

MOVEMENT CONDENSE EXPAND AVERAGE SPEED

TOTAL SPEED MEASUREMENT ENERGY DEGREES

CALORIES MILES PER HOUR MASS GRAMS PER MILLILITERHEAT AND THERMODYNAMICS

Sec Review 10-1

2. A hot copper pan is dropped into a tub of water. If the water's temperature rises, what happens to the temperature of the pan? Why? Draw a picture of the molecules doing this. How will you know when the water and copper pan reach thermal equilibrium?

The pan's temperature will decrease. The molecules are bumping into each other, and in the collisions the fast ones become slower and the slow ones become faster. When they are all moving at similar speeds, their temperature will all be the same.

5. Which of the following statement(s) is true for water molecules inside popcorn kernels during popping?

a) temperature increases b) they are destroyed!

C) kinetic energy increases D) mass changes

6. If a hot plate is used to heat a bowl of hot oil and popcorn which objects are in thermal equilibrium after 15 min?

Hot plate and glass pot ***hot oil and kernels*** air and hot plate air and pot. ***(The air would never be in equilibrium, its way too big)***

CC. 1 If I drop an object to the floor and it does NOT bounce, is mechanical energy conserved? How could you prove this?
NO, mechanical energy is not conserved, the gravitational potential energy was not all changed to kinetic… some changed to heat. I could prove it by checking to see if the object changed temperature.

If I apply the same amount of heat energy to two different substances will the temperature change the same amount? Why or why not? What does this depend on?
The temperature change will depend on the material, its specific heat and heat conductivity, as well as the mass.

Sec Review 10-2
1. A bottle of water at room temperature is placed in a freezer for a short time. An identical bottle of water that has been lying in the sunlight is placed in a refrigerator for the same amount of time. What must you know to determine which situation involves more energy transfer?
We need to know the starting temperature of the freezer and room temp, and the starting temp of the fridge and sunlight temp. Whichever has a larger change in temperature will have the larger energy transfer.

2. Use the microscopic interpretations of temperature and heat to explain how you can blow on your hands to warm them, then blow on soup to cool it. ***Well, it's not that you decide that one day your breath is hot, then it is cold (although there is that weird expression blowing hot and cold, sigh…. Does anyone really read these answers? Am I just doing this for my amusement? Extra points! if you email me now at RichTherrn@richtherrn.com and tell me!***
The answer is that if your breath (37 °C) is warmer than your cold (10 °C) hands, it warms them. If your breath (37 °C) is colder than your hot (75°C) soup, it cools it.

3. IF a bottle of water is shaken vigorously, will the internal energy of the water change? Why or why not?
Sure…. You are adding kinetic energy, and instead of making every molecule move in the same direction (throwing it), you are making them move back and forth, colliding, rubbing, etc… causes the average kinetic energy to increase, thus the temperature.

4. Water at the top of Niagara Falls has a temperature of 10 °C. If 505 kg of water falls 50 meters, what will the temperature increase of the water at the bottom be?

GPE = mgh = 505*9.8*50 =247, 450 Joules
GPE at bottom = 0!
ΔQ = ΔGPE = m C ΔT =505 (4187) (ΔT) = 247, 450 Joules
ΔT = 247, 450 / (505 *4187) = 0.117 °C

Practice 10B #4 A worker drives a .5 kg spike into a rail tie with a 2.5 kg sledgehammer. The hammer hits the spike with a speed of 65 m/s. If 1/3 of the kinetic energy is transferred to the hammer's internal energy, how much does the internal energy increase? What would you need to know to calculate the temperature change?
Hammer has Kinetic Energy = ½ m v^2 = ½ (2.5) $(65)^2$ = 5281.25 Joules, 1/3 of that is 1760.4 Joules of increase. I would also need to know the specific heat of the spike and hammer to calculate the temperature change. If they were both made of iron:
1760.4 = m C ΔT = 3.0 C ΔT